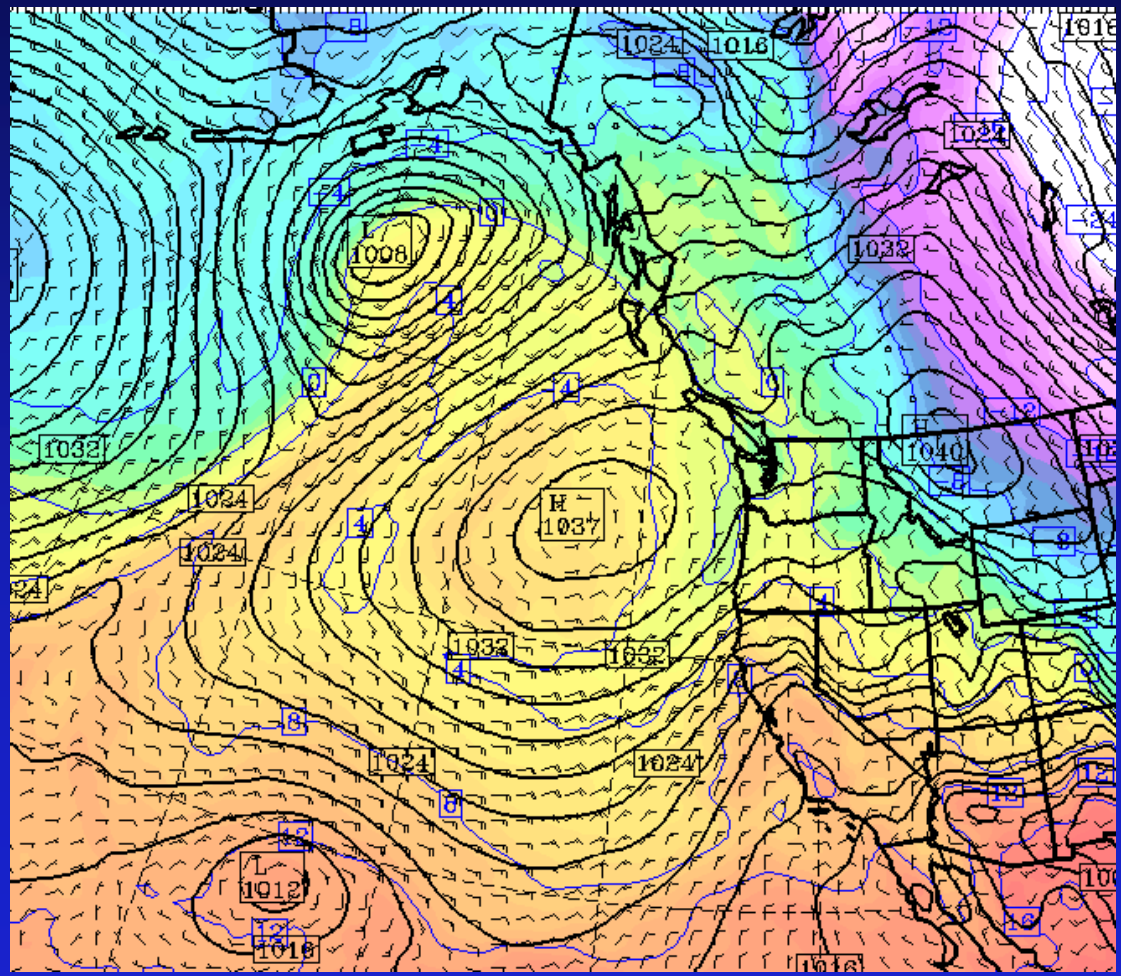
Regional Modeling Update

March 5, 2005

Cliff Mass, Dave Ovens, Rick Steed, Jeff Baars, Eric Grimit, Mark Albright, Phil Regulski

University of Washington



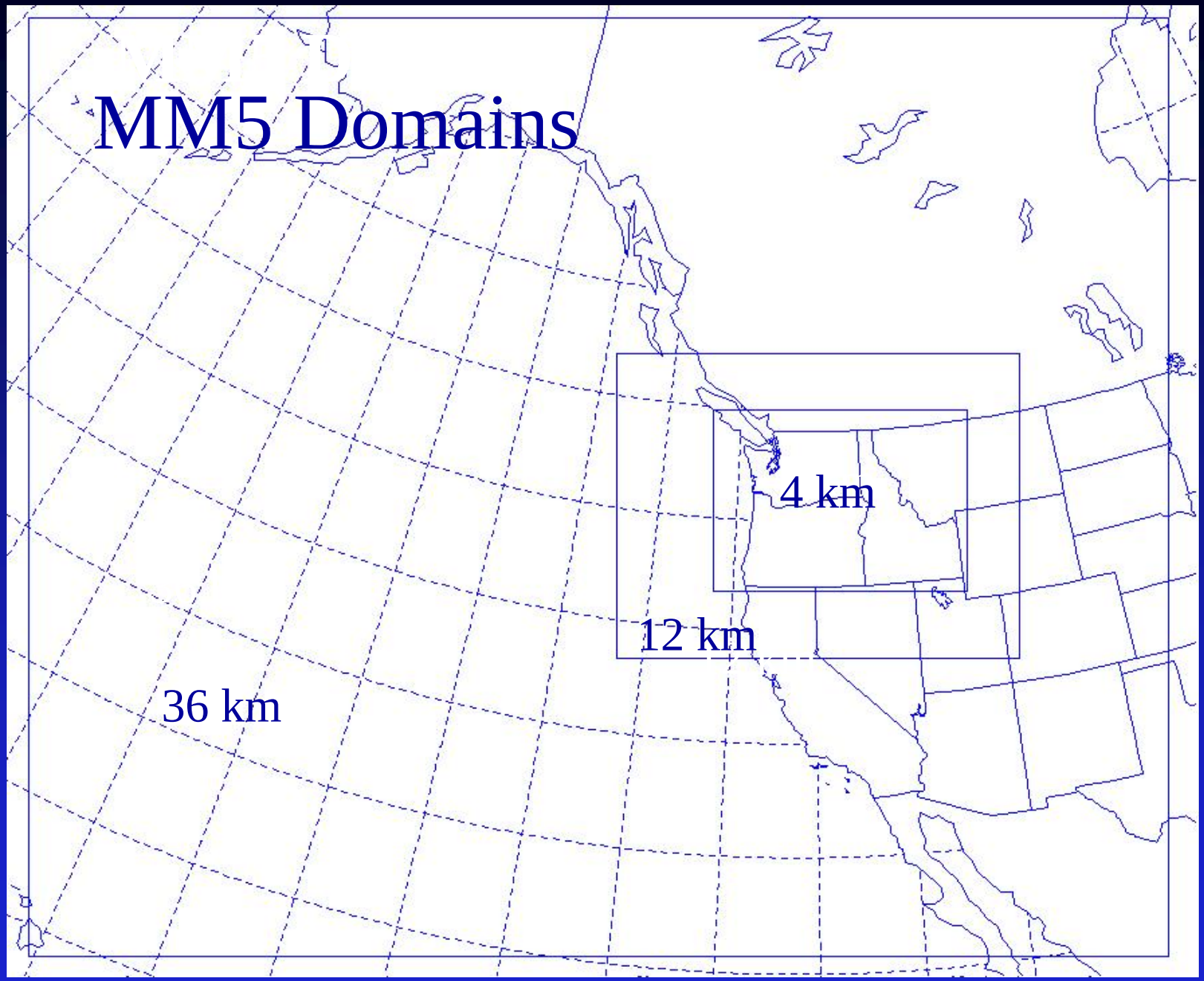
There Have Many Changes Since Last Year

- New computers and increased robustness
- Improved physics
- Revamped regional ensemble system
- Addition of WRF model run
- Many new products

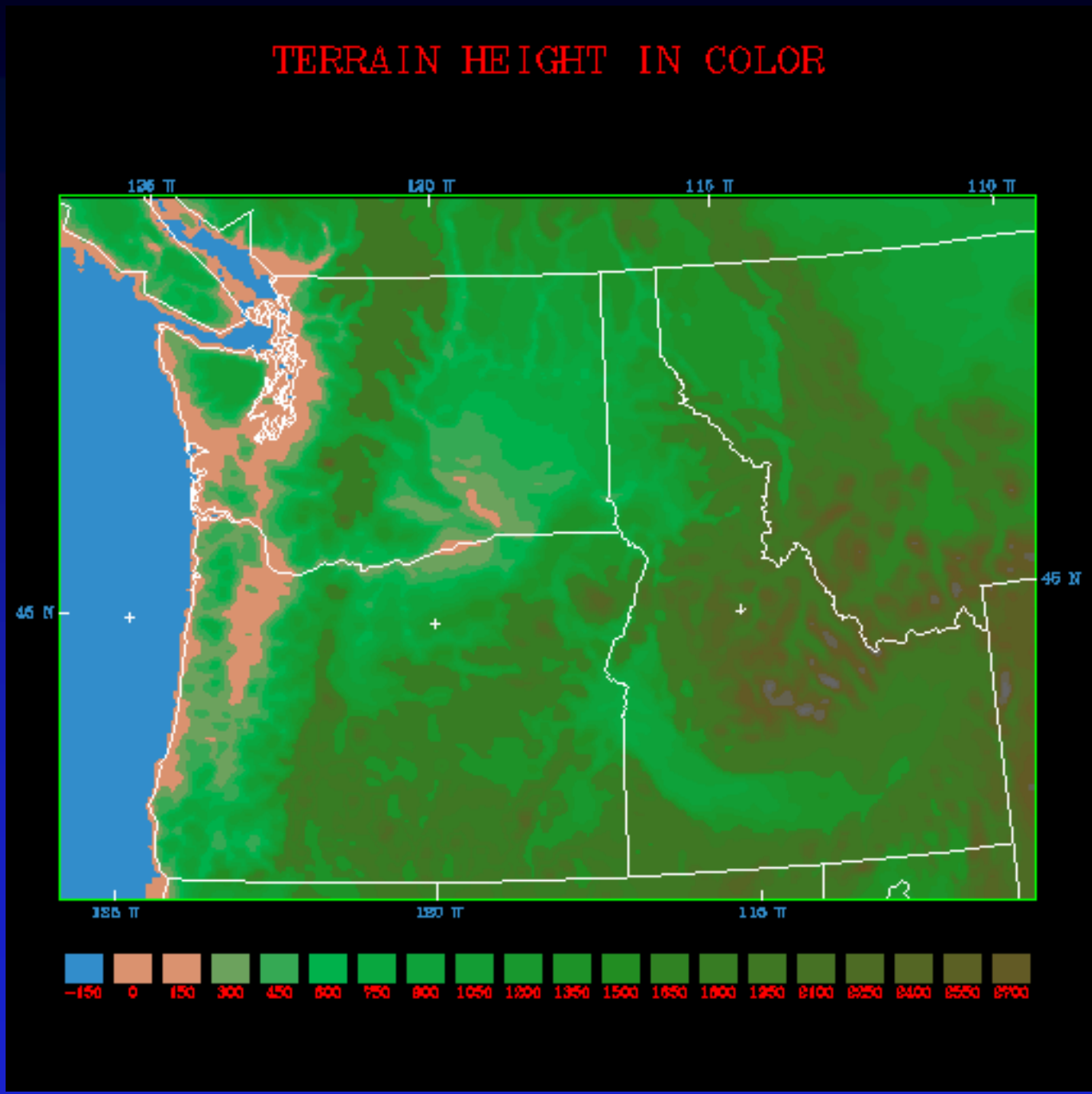
Still using the MM5 model for the high resolution runs

- Now using MM5 V3.63
- 36-12-4 km grid spacing
- 38 levels

MM5 Domains



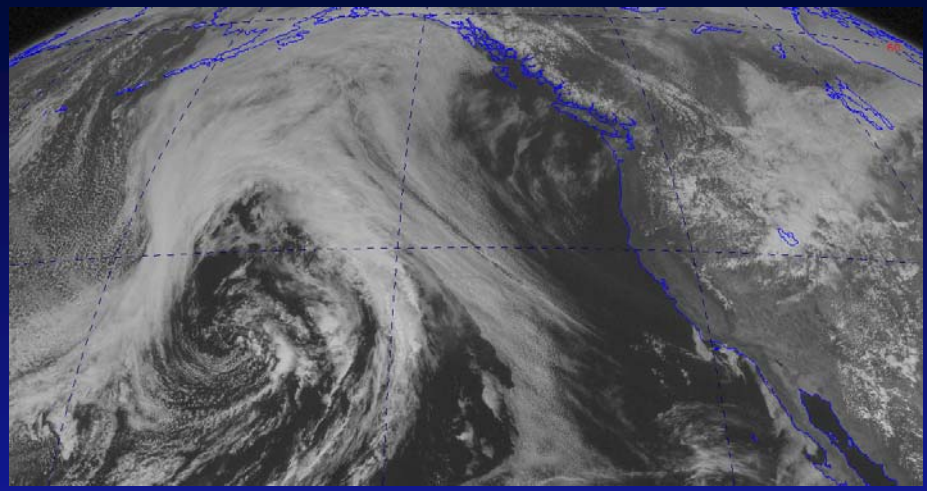
4-km domain


TERRAIN HEIGHT IN COLOR
125 W
120 W
115 W
110 W
45 N
45 N
125 W
120 W
115 W
-150
0
150
300
450
600
750
900
1050
1200
1350
1500
1650
1800
1950
2100
2250
2400
2550
2700

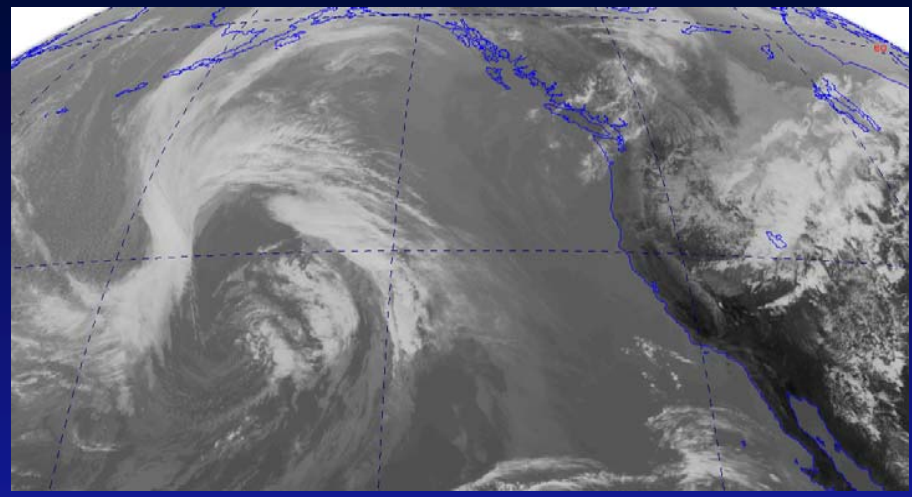
Microphysics

- This year we switched our primary real-time microphysics to the new Reisner II scheme, which included graupel and supercooled liquid water.
- It has provided substantial improvements in some areas (less fictitious blow-over to the lee side under strong winds, much better cloud fields)

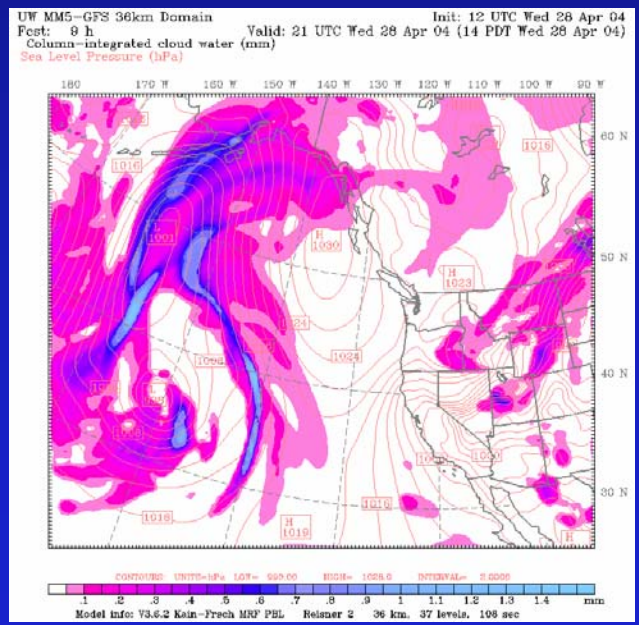
Visible



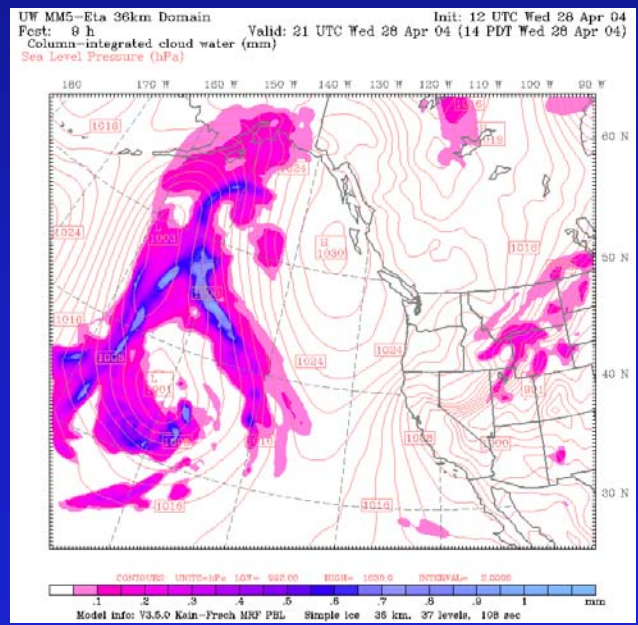
Infrared



Reisner



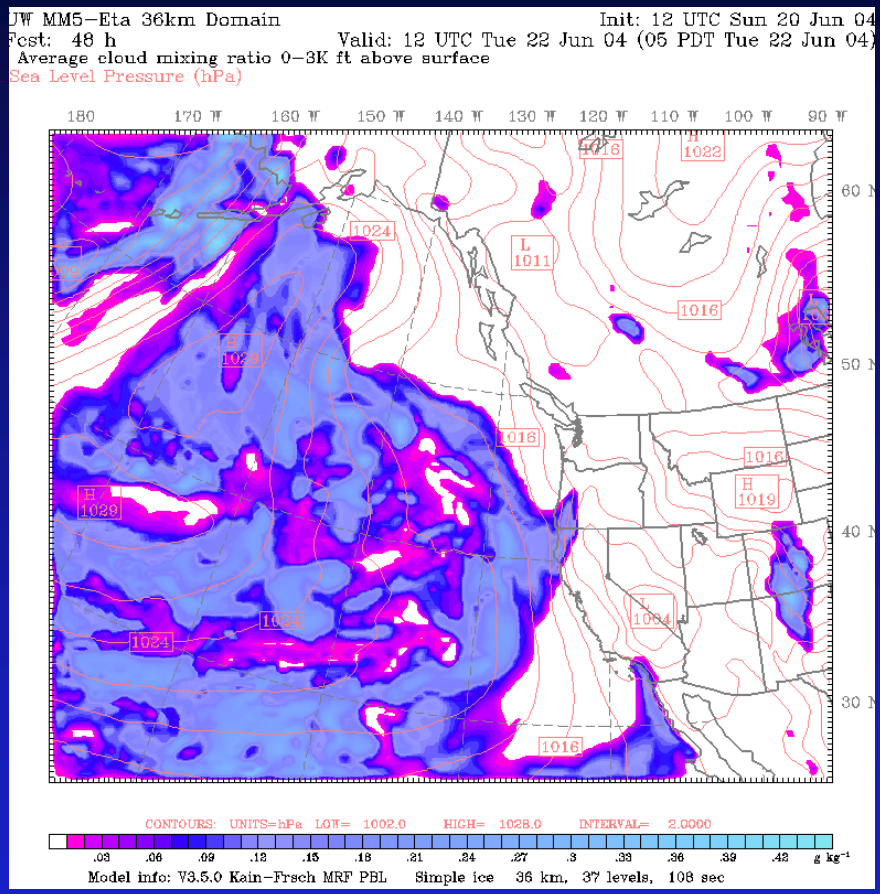
Simple Ice

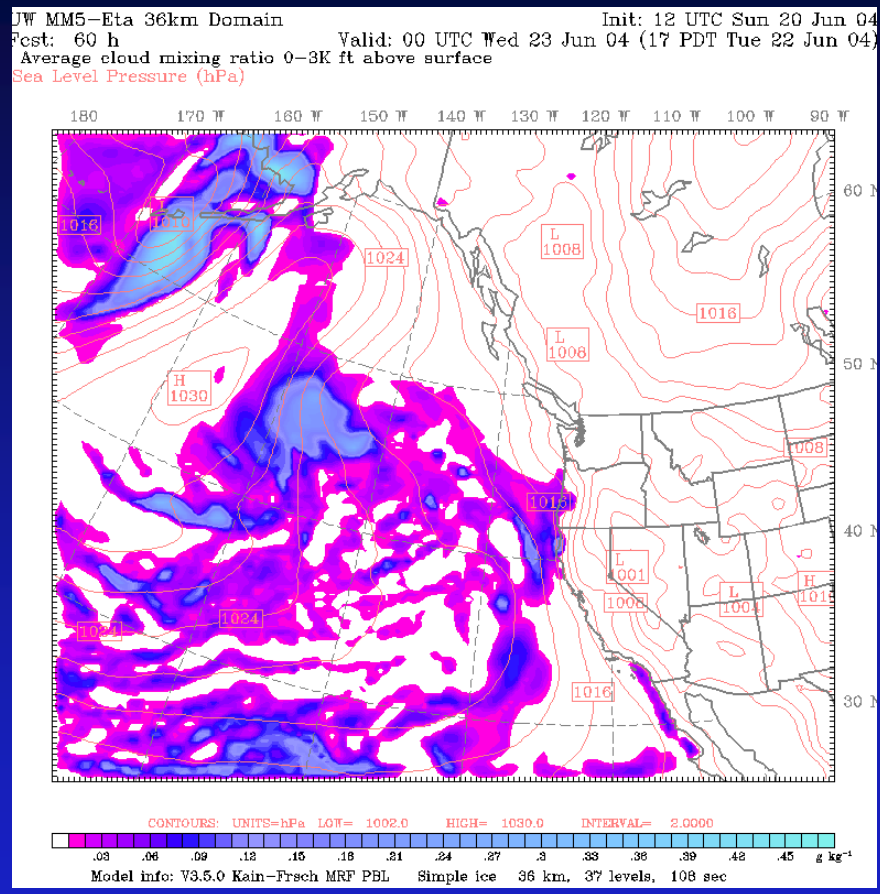


Radiation Problems

- The radiation scheme were were using (Dudhia) had a number of problems, such as excessive absorption of solar radiation by clouds.
- This is particularly obvious for stratus/stratocumulus over the Pacific.

Dudhia Radiation Scheme Burn-off Problem





0-3K ft Cloud Mixing Ration

48 h, 5 AM PDT

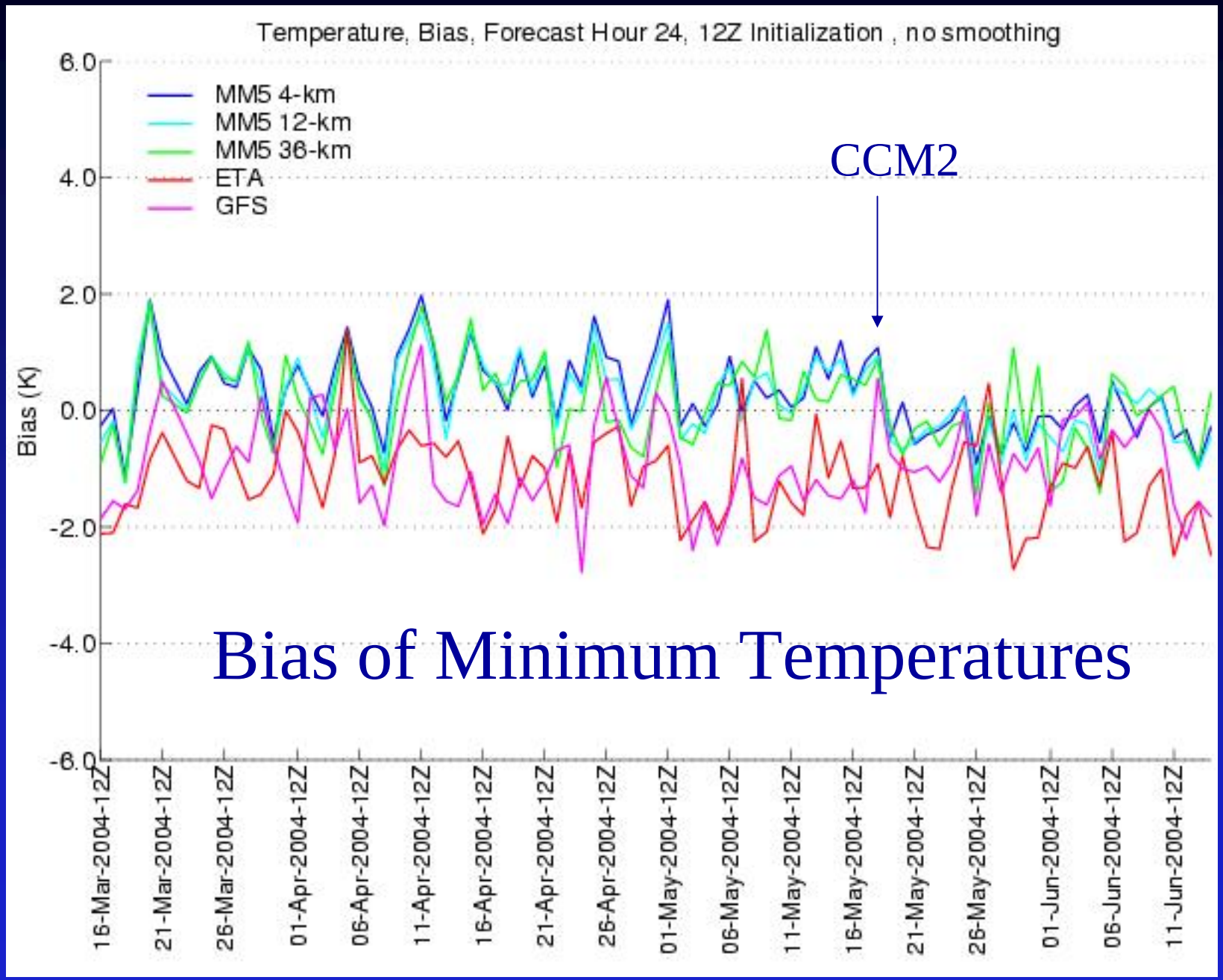
60h, 5 PM PDT

Both are using simple ice microphysics scheme

In the real-world, burn-off is minor

Radiation Schemes

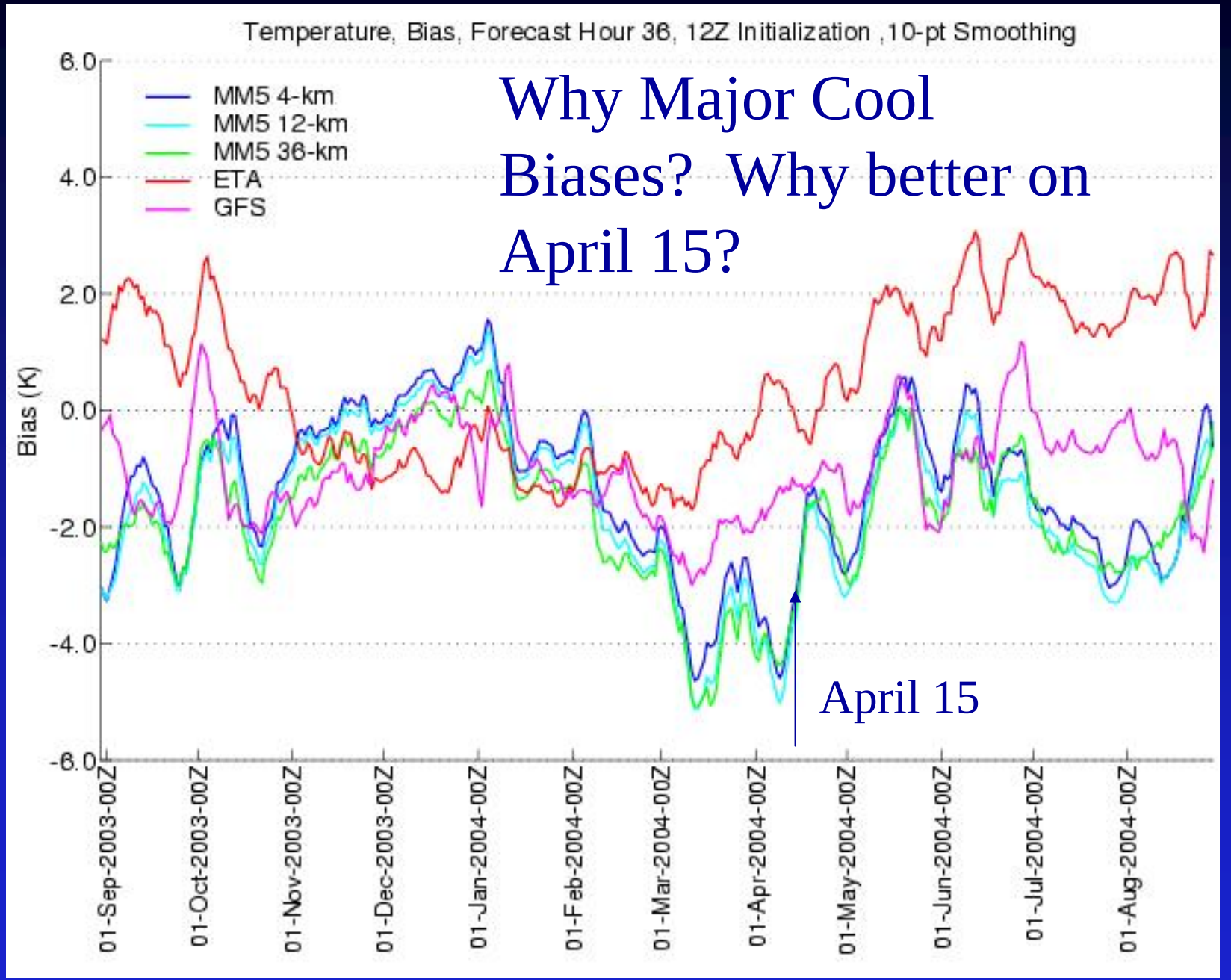
- We switched to the more complex Community Climate Model Two (CCM2 scheme with some of our own corrections to the size of ice particles.
- This also improved our minimum temperatures at night…which had been too warm. In addition, maximum temperatures were better (higher).



Bias of Minimum Temperatures

Radiation Scheme

- The result of the current Reisner/ modified CCM2 combination was the best surface temperature verification statistics we have ever had, without the old problem of of lack of diurnal range. Until the next problem appeared…… poor soil moisture distributions.


Temperature, Bias, Forecast Hour 36, 12Z Initialization ,10-pt Smoothing
MM5 4-km
MM5 12-km
MM5 36-km
ETA
GFS
Why Major Cool Biases? Why better on April 15?
April 15
Bias (K)
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
01-Sep-2003-00Z
01-Oct-2003-00Z
01-Nov-2003-00Z
01-Dec-2003-00Z
01-Jan-2004-00Z
01-Feb-2004-00Z
01-Mar-2004-00Z
01-Apr-2004-00Z
01-May-2004-00Z
01-Jun-2004-00Z
01-Jul-2004-00Z
01-Aug-2004-00Z

The Large Influence of Soil Moisture on Maximum Temperatures

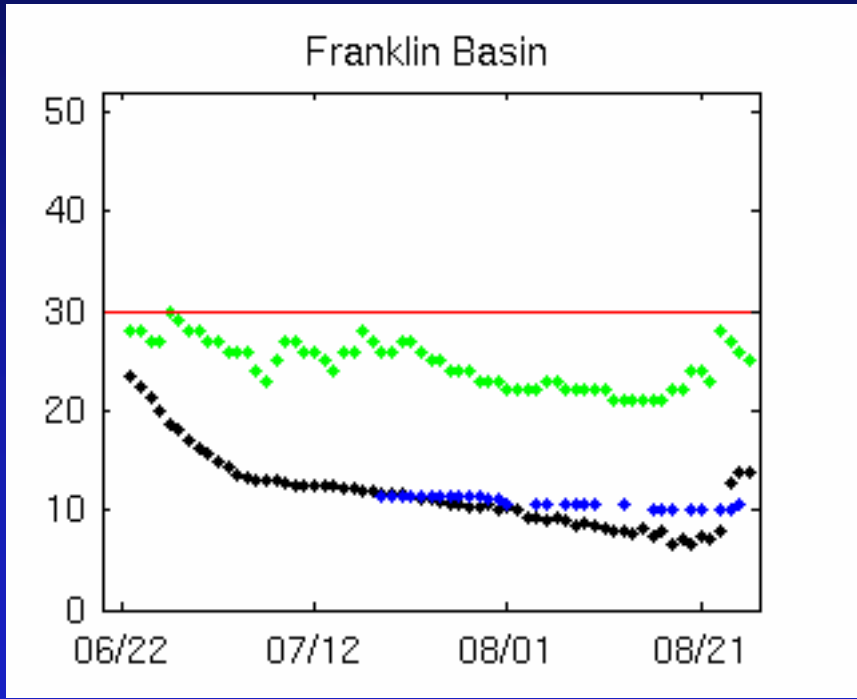
- At that time we used the default surface characteristics in MM5, with the corresponding soil moistures. But 2004 was unusually dry and by March the soil moisture was more typical of summer over much of the domain. Less moisture resulted in less evaporative/latent heat flux and thus warmer maxima.
- On 15 April, we switched to the summer land use and the results improved

But then the cold bias returned..

- The reason: dry and warm summer resulted in the default summer soil moistures being too moist.
- We tried using the soil moistures from the NCEP Eta model..which uses the fairly sophisticated NOAH land surface model…but that didn’t help. Why?

Soil Moisture at a Representative Site

Observations *
Eta Model NOAH LSM *
NOAA FSL RUC Model *
----MM5 Default

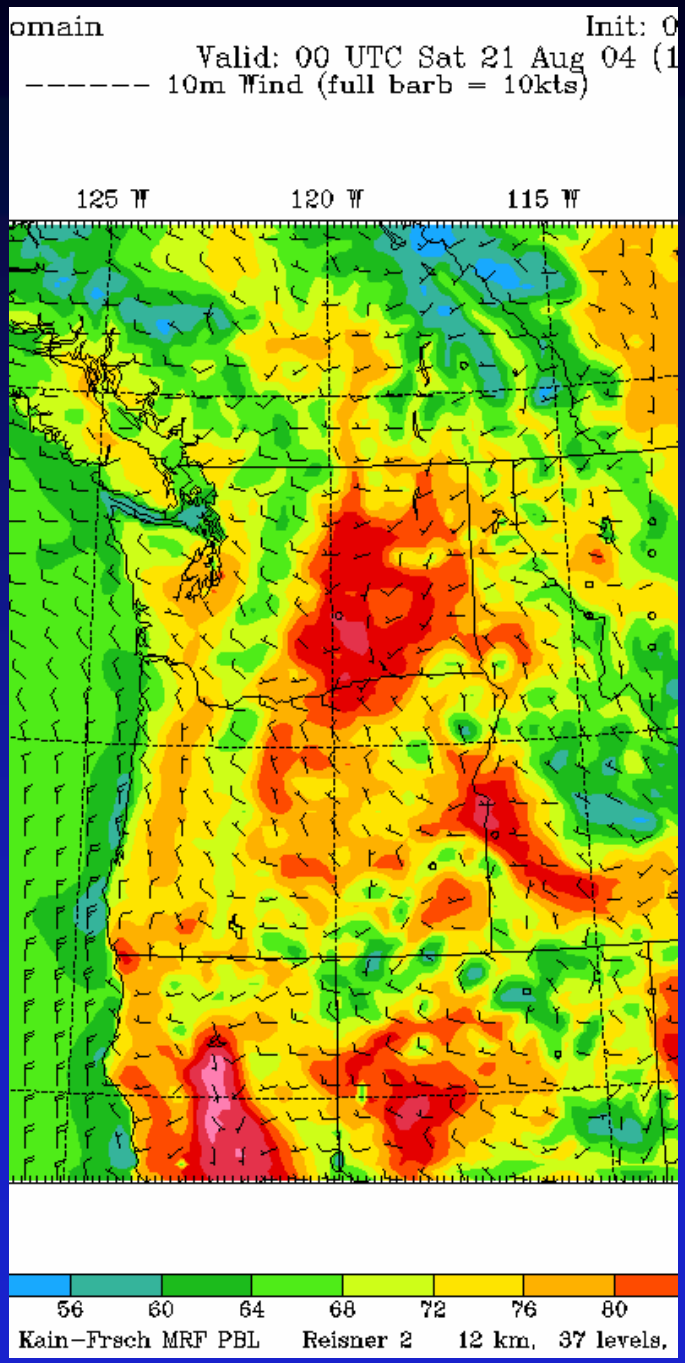


Both the Eta and MM5 default soil moistures were too wet. Thus, simply running a sophisticated land surface model does not necessarily give you the right answer.

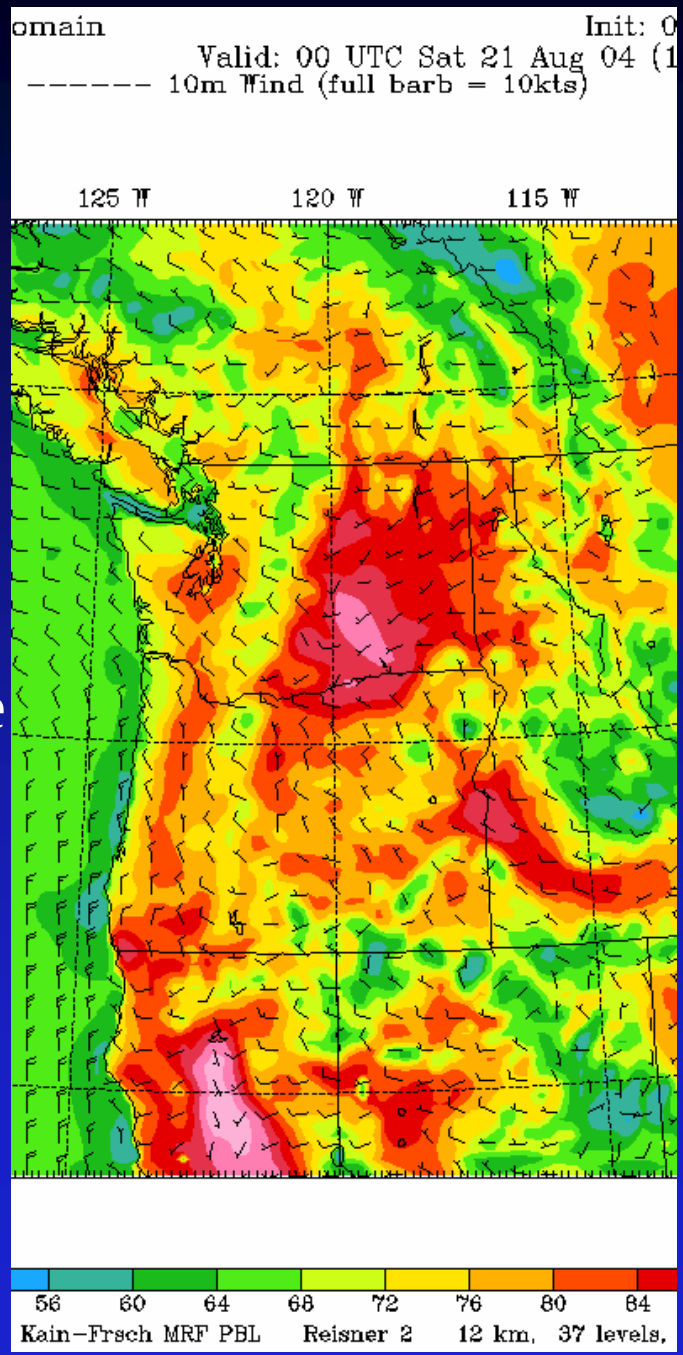
The Fix

- We now update our soil moisture daily with the NOAA RUC soil moisture analysis, with a dump bucket approach during the run
- The results: our cold bias problem is gone….for now….

Old Default



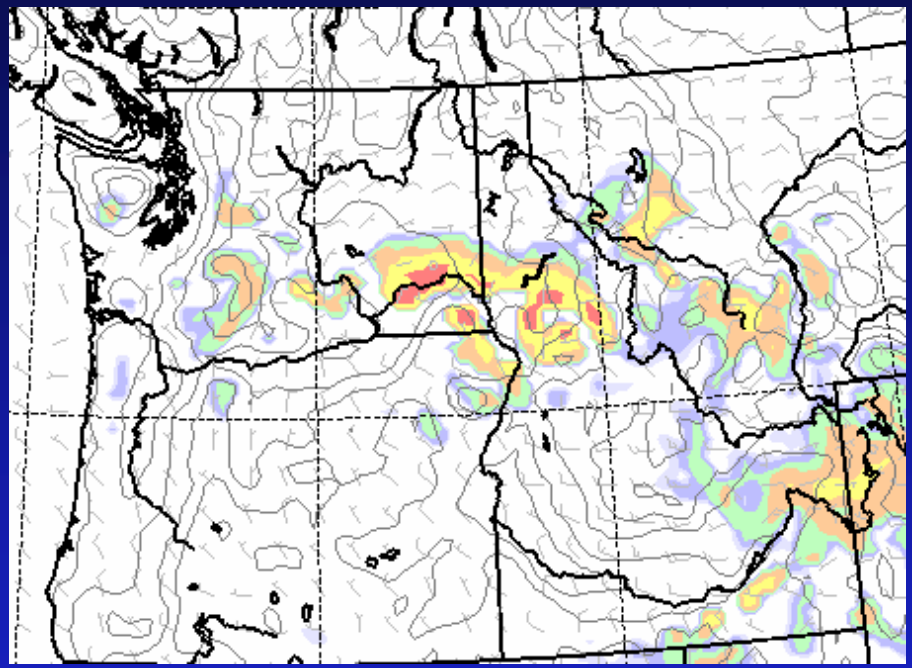
Updated Soil Moisture



Cumulus Parameterization

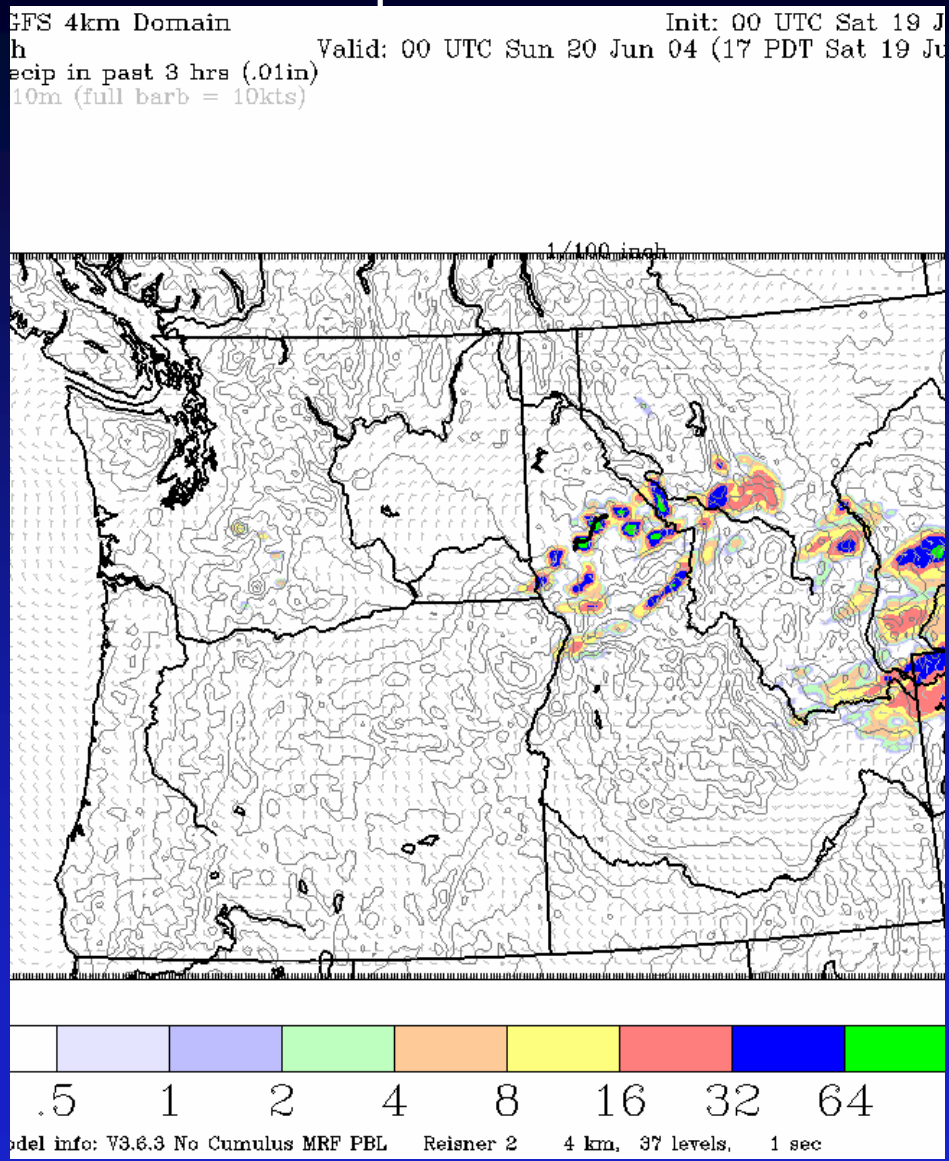
- Until last summer we had cumulus parameterization (Kain-Fritsch) on the 36 and 12-km domains, and no parameterization in the 4-km nest.
- Reasoned that 4-km was enough resolution to deal with convection.
- Unfortunately, we noted a **suppression** of convection in the 4-km nested domain that was not realistic.
- It appears that having the parameterization on in the 36 and 12-km domains was the cause.

12-km



Parameterized

Explicit

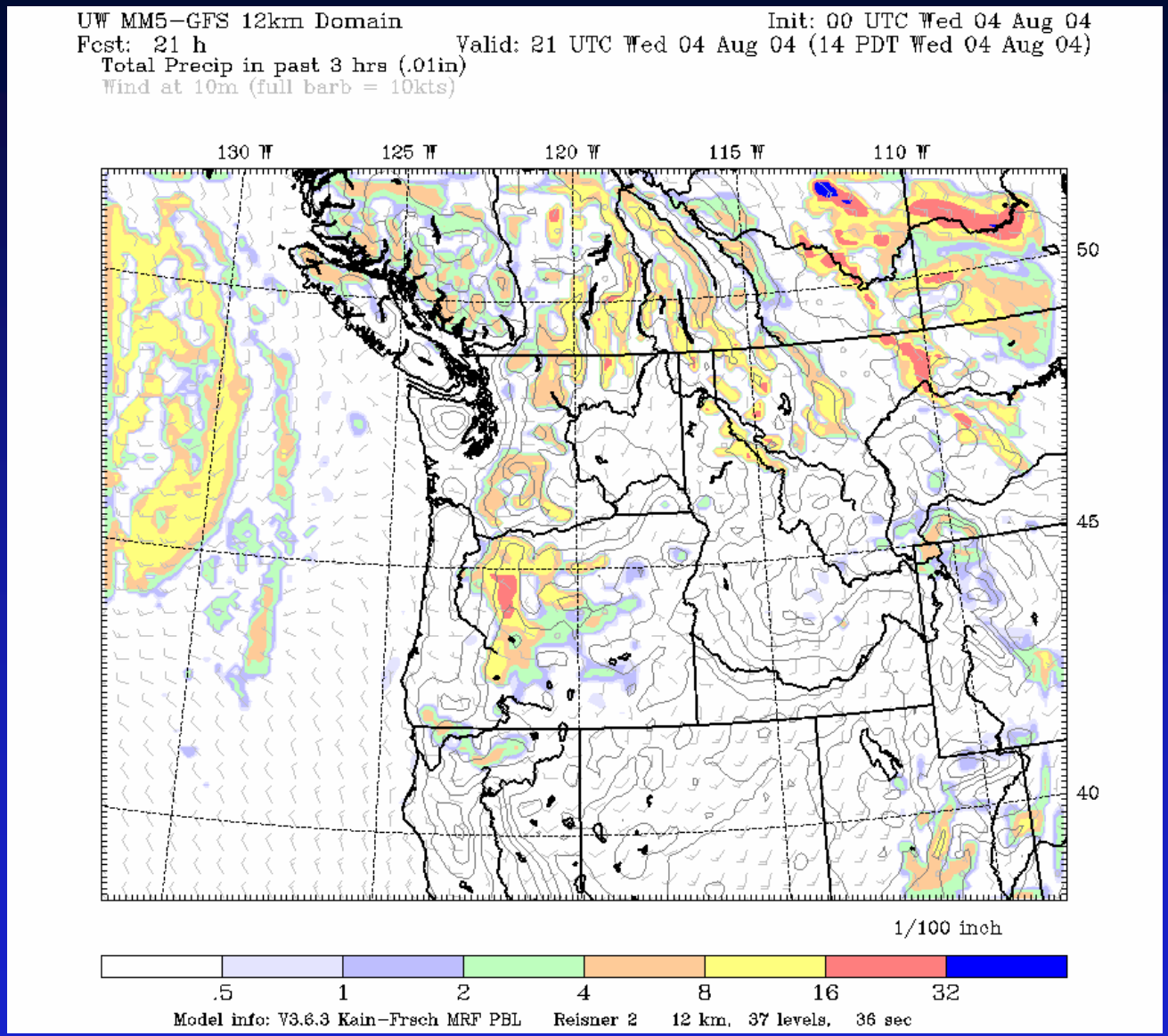


4-km

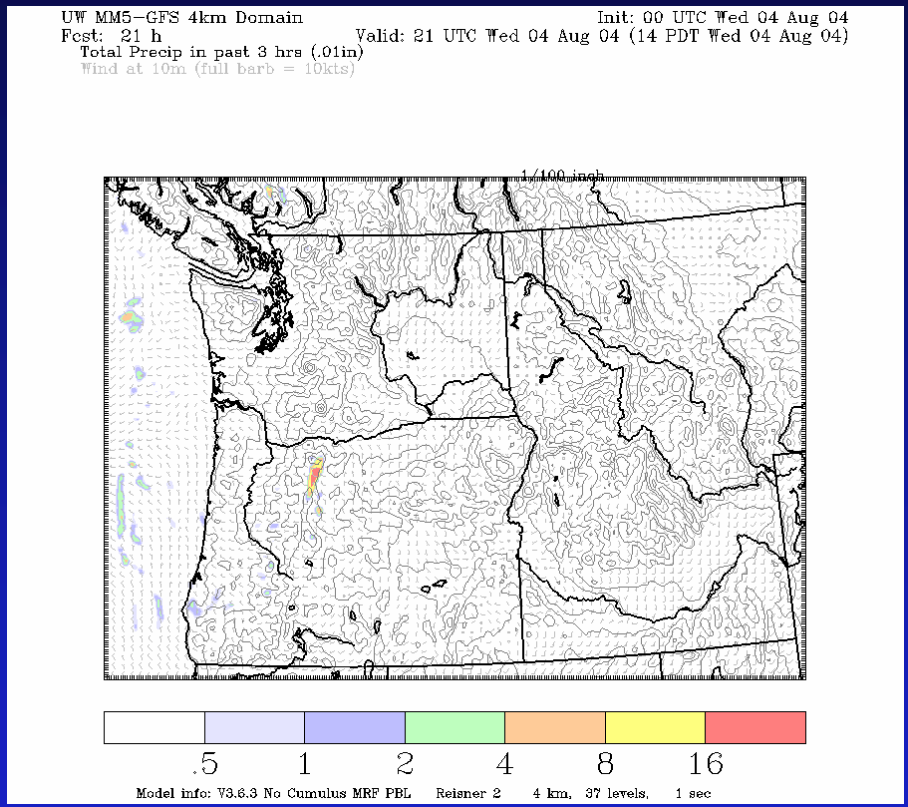
A Fix

- After talking to Jack Kain (creator of the Kain-Fritsch parameterization) and George Grell (Grell CU scheme), it appeared to make sense to add the cumulus parameterization to the 4-km domain.
- The results have been quite good…making the 12 and 4-km convection quite comparable.

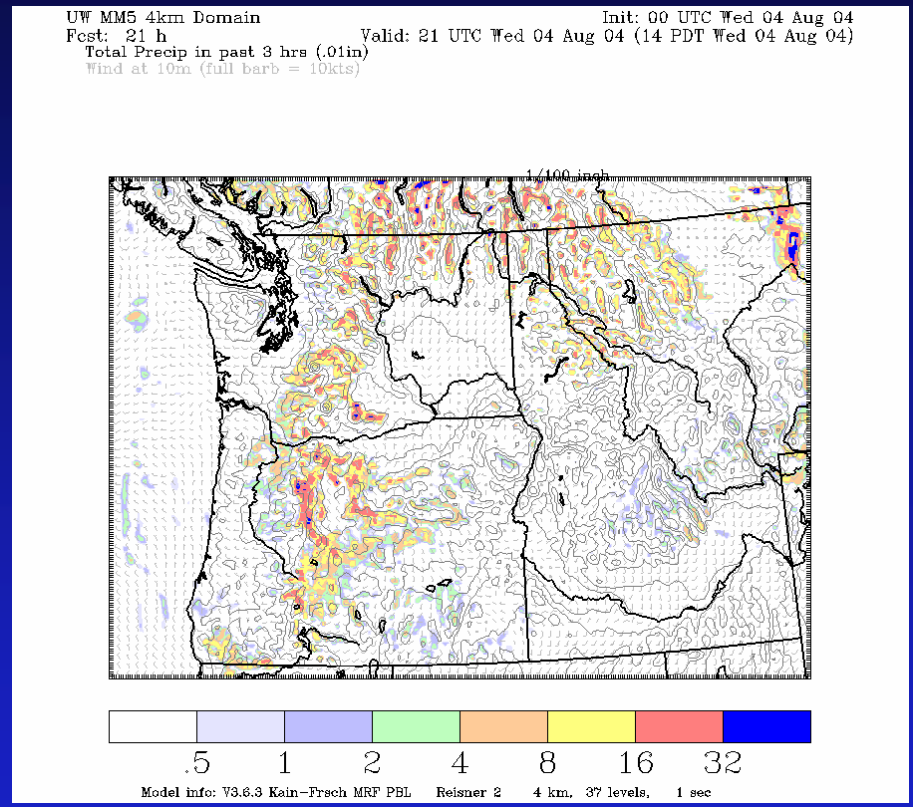
12-km 3-h Precipitation



4-km Precipitation



Totally Explicit



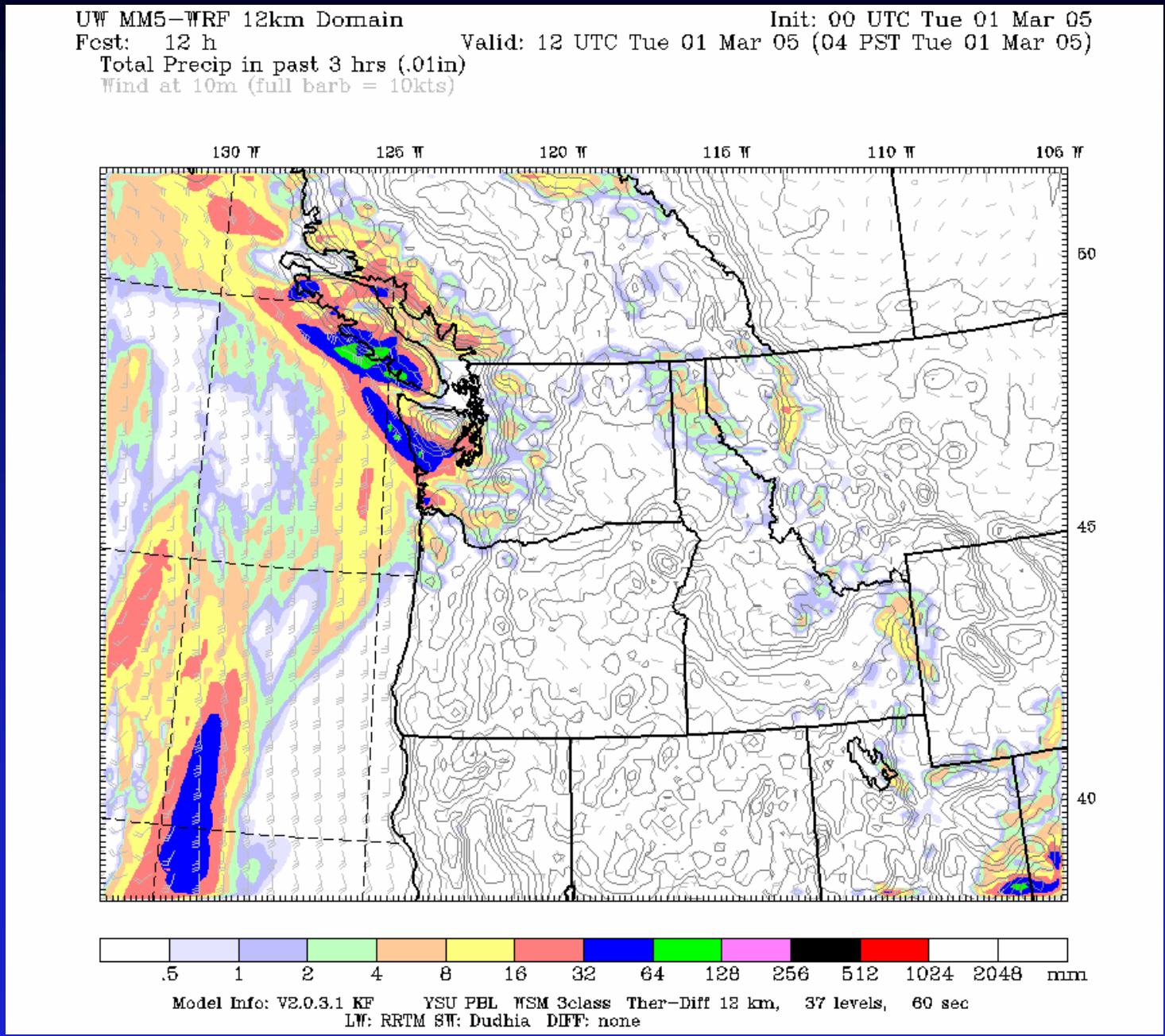
With KF CU Parameterization
In 4-km Domain

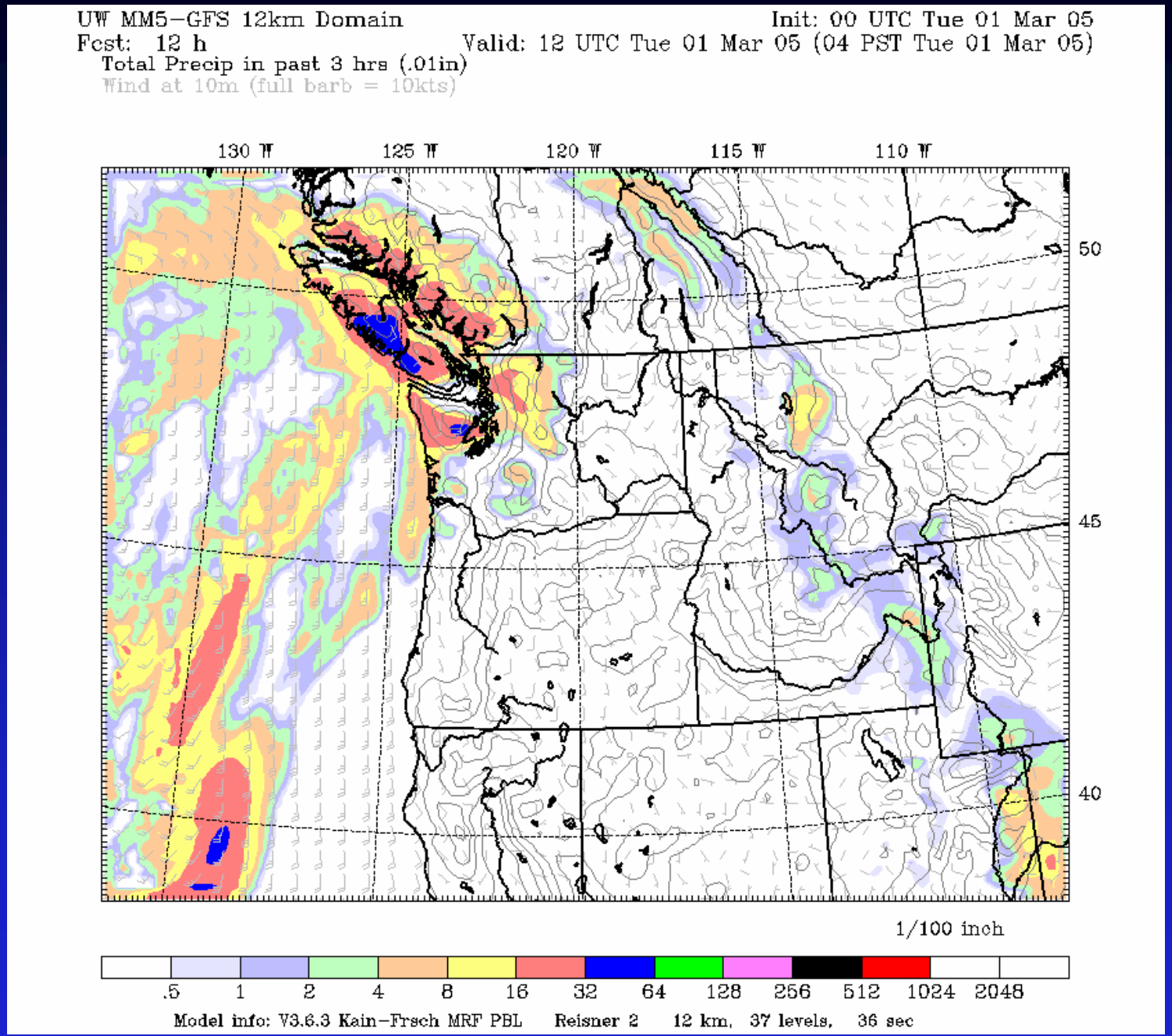
Started Running the Next-Generation Mesoscale Model: WRF

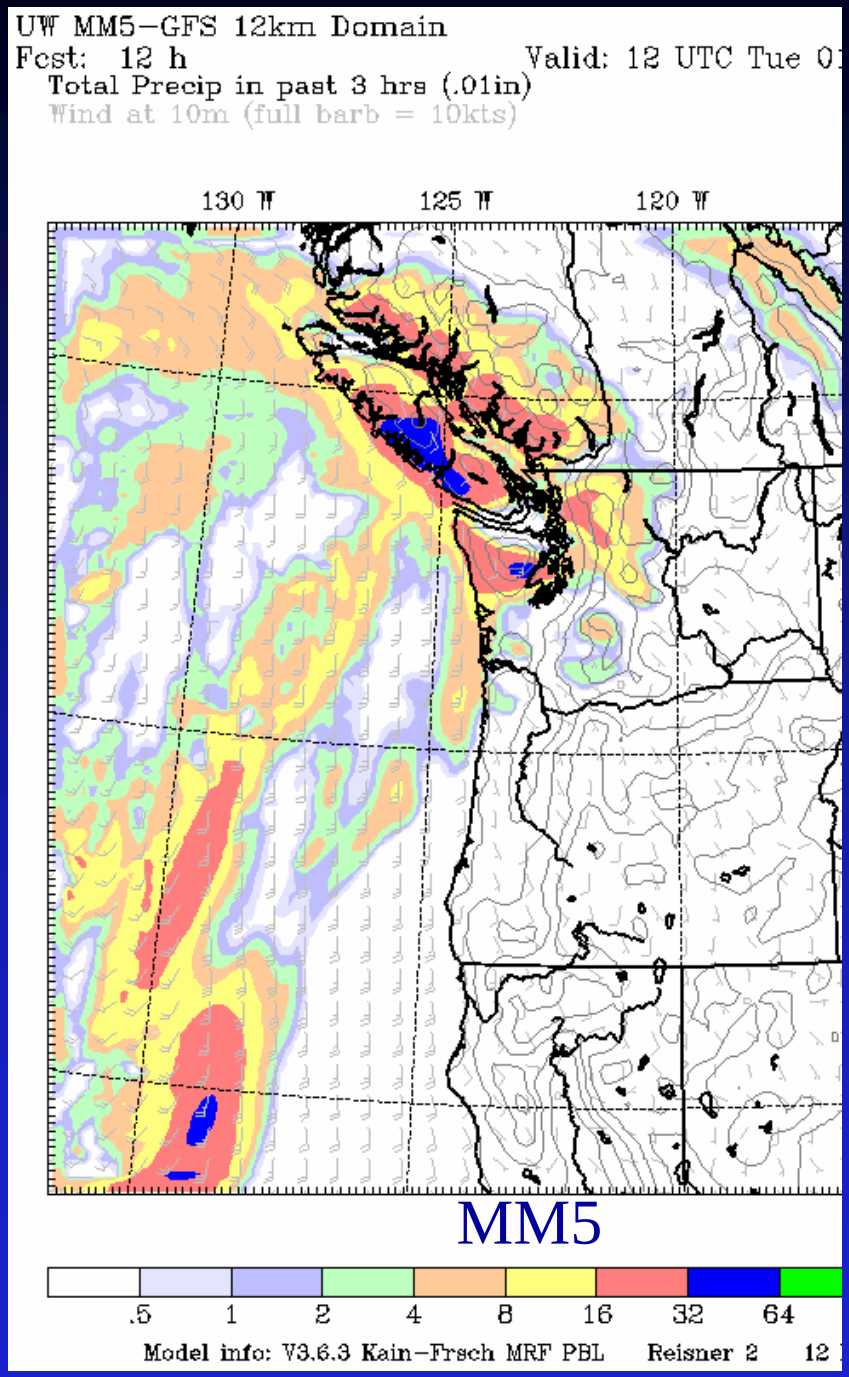
- WRF is a new national mesoscale model that is being jointly developed and used by the operational and academic communities.
- Replaces the MM5 (i.e., represents MM6)
- Better numerics and designed for parallelization.
- Modular physics for easy physics development

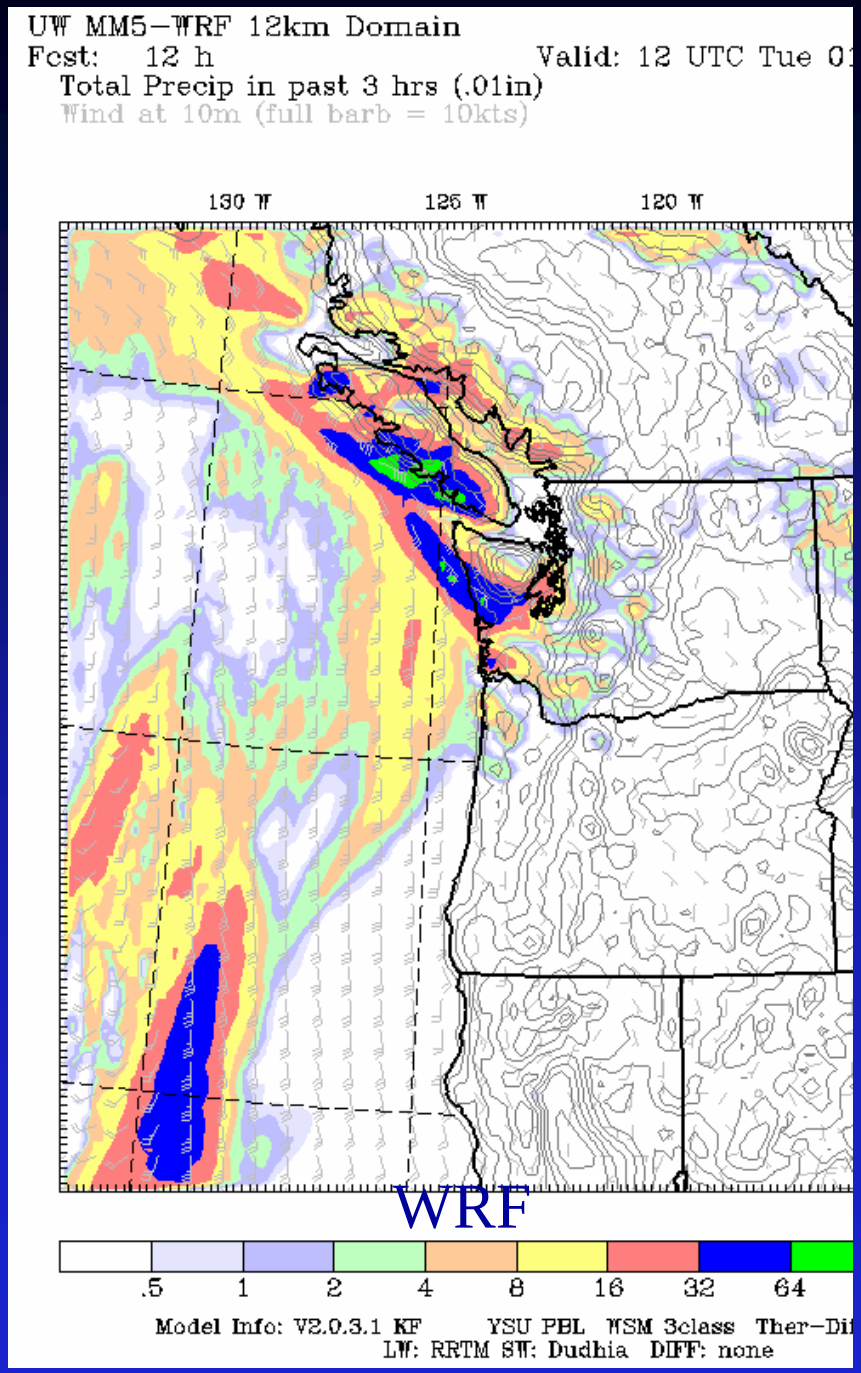
UW WRF

- Starting in late January, the UW has been running WRF (ARW core) at 36-12 km.
- These domains are essentially the same as the MM5.
- Runs once a day out to 48-h.
- Will be carefully verifying it over the next 6 months to determine whether we should switch.
- WRF web pages are online.
- Early view… tighter and more defined structures…but slower to run.


UW MM5-WRF 12km Domain
Init: 00 UTC Tue 01 Mar 05
Fcst: 12 h
Valid: 12 UTC Tue 01 Mar 05 (04 PST Tue 01 Mar 05)
Total Precip in past 3 hrs (.01in)
Wind at 10m (full barb = 10kts)
130 W
125 W
120 W
115 W
110 W
105 W
50
45
40
.5
1
2
4
8
16
32
64
128
256
512
1024
2048
mm
Model Info: V2.0.3.1 KF YSU PBL WSM 3class Ther-Diff 12 km, 37 levels, 60 sec
LW: RRTM SW: Dudhia DIFF: none


UW MM5-GFS 12km Domain
Init: 00 UTC Tue 01 Mar 05
Fcst: 12 h
Valid: 12 UTC Tue 01 Mar 05 (04 PST Tue 01 Mar 05)
Total Precip in past 3 hrs (.01in)
Wind at 10m (full barb = 10kts)
130 W
125 W
120 W
115 W
110 W
50
45
40
1/100 inch
.5
1
2
4
8
16
32
64
128
256
512
1024
2048
Model info: V3.6.3 Kain-Frsch MRF PBL Reisner 2 12 km, 37 levels, 36 sec

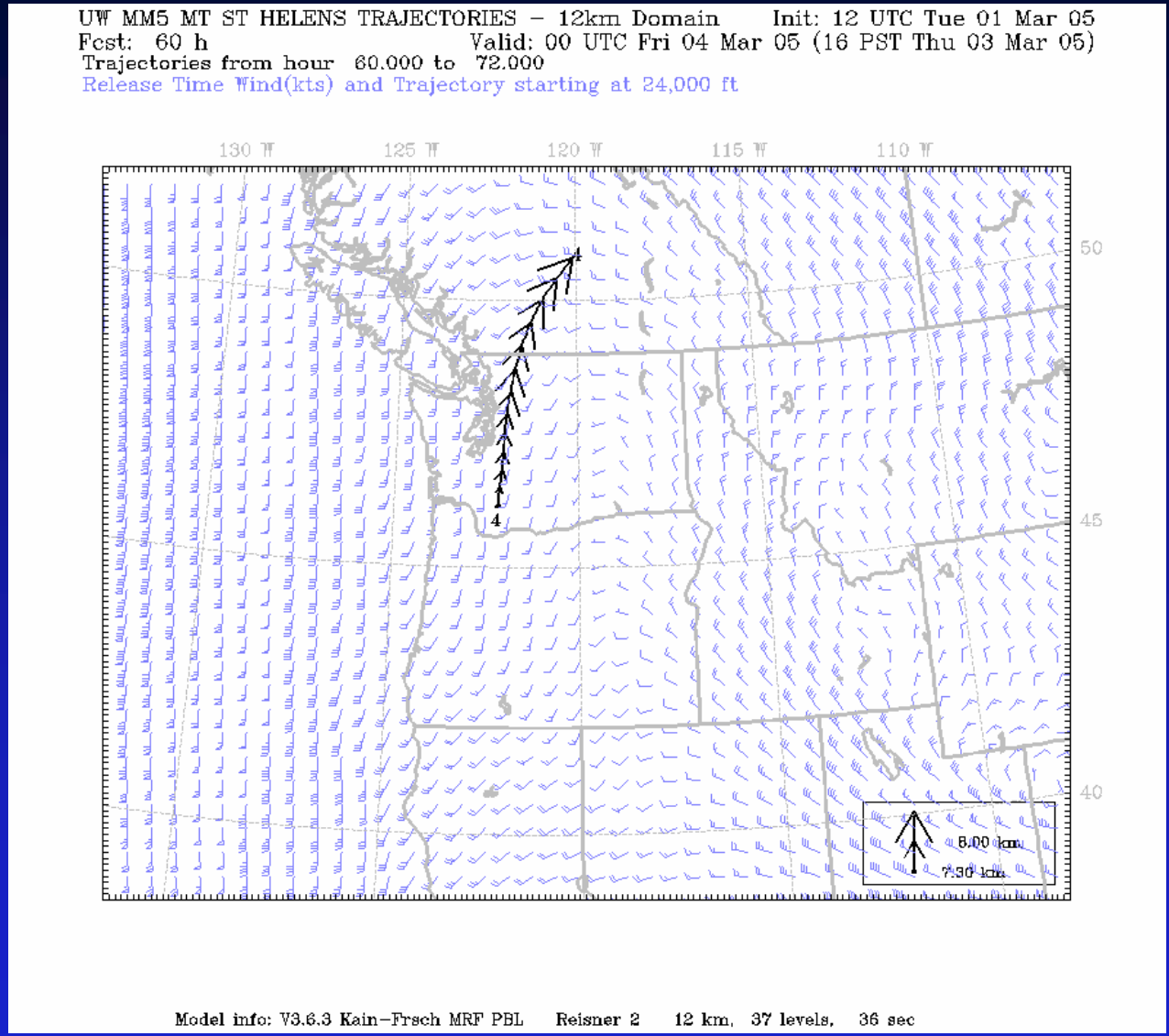

UW MM5-GFS 12km Domain
Fcst: 12 h
Valid: 12 UTC Tue 0
Total Precip in past 3 hrs (.01in)
Wind at 10m (full barb = 10kts)
130 W
125 W
120 W
MM5
.5
1
2
4
8
16
32
64
Model info: V3.6.3 Kain-Frsch MRF PBL Reisner 2


UW MM5-WRF 12km Domain
Fcst: 12 h
Valid: 12 UTC Tue 0
Total Precip in past 3 hrs (.01in)
Wind at 10m (full barb = 10kts)
130 W
125 W
120 W
WRF
.5
1
2
4
8
16
32
64
Model Info: V2.0.3.1 KF YSU PBL WSM 3class Ther-Di
LW: RRTM SW: Dudhia DIFF: none

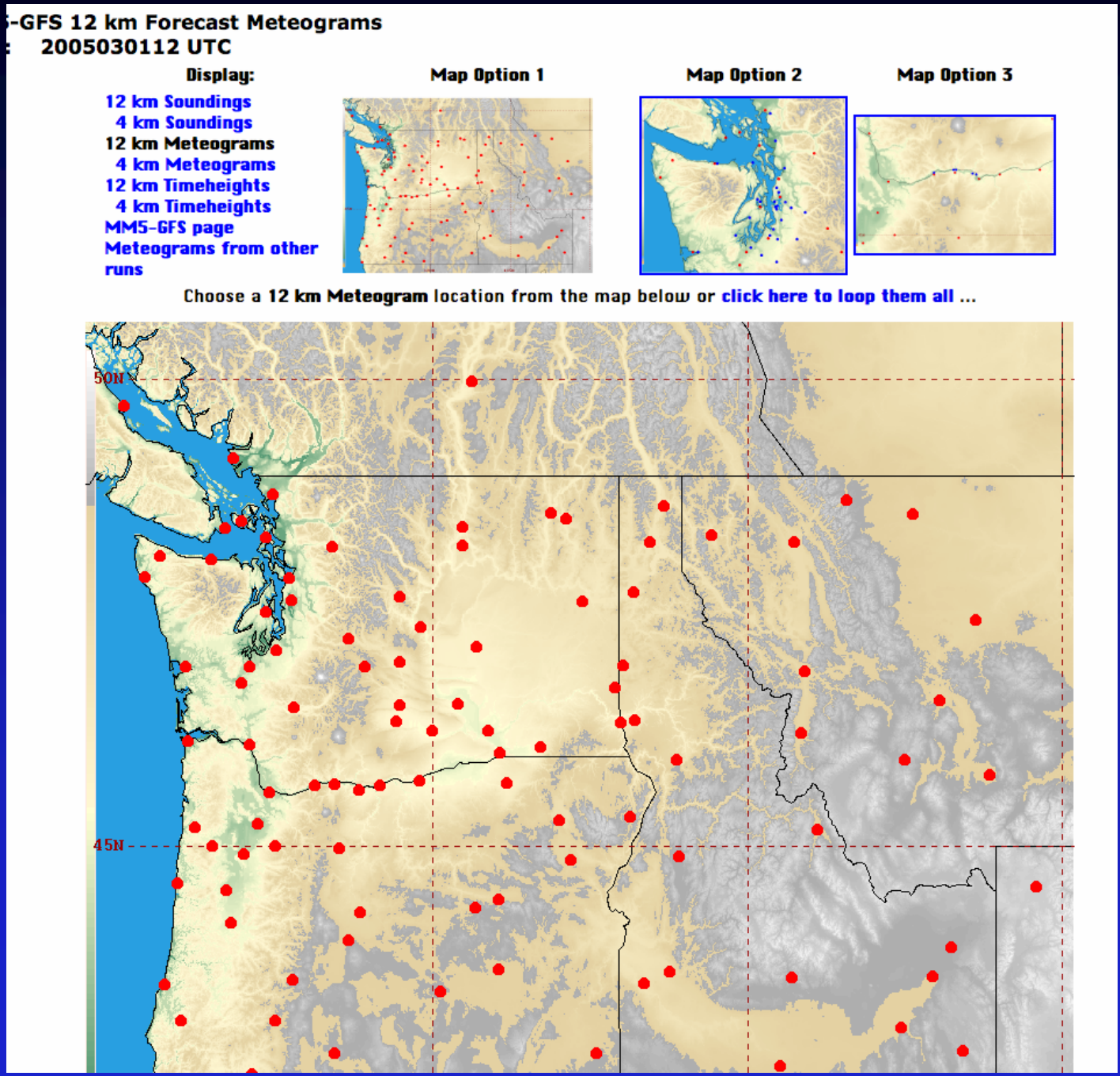
Many new products available on MM5 web site

…a few samples

Mount St. Helens Air trajectories from multiple levels.

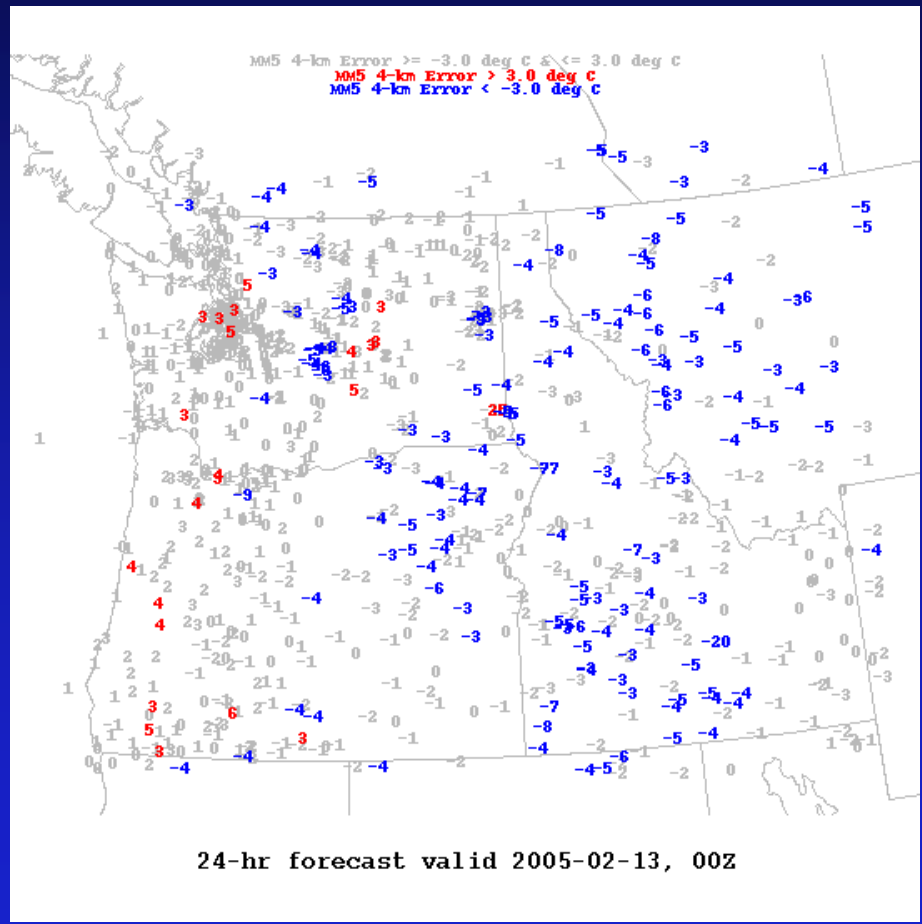


More Meteograms and Time Height Cross Sections



Improved Verification

- Major improvements to our verification web site….by Jeff Baars… including time series and map displays



Other Major Advances

- Improved Ensemble System and output graphics (see talks by Rick Steed and Eric Grimit)
- Improved quality control of observations (see talk by Jeff Baars)
- Development of grid-based bias removal (see talk of Garrett Wedam)

The END